WHAT IS CLAIMED IS:

1. A solid oxide fuel cell, comprising:

an anode;

a cathode; and

an ionically conducting solid oxide electrolyte disposed between the anode and the cathode;

wherein the solid oxide electrolyte comprises at least one first region having a relatively high operating temperature and at least one second region having a relatively low operating temperature;

and wherein the composition of the solid oxide electrolyte is different in the first and second regions.

2. The solid oxide fuel cell according to Claim 1, further comprising:

at least one fuel supply passage configured to supply at least one fuel to the anode; and

at least one oxidant supply passage configured to supply at least one oxidant to the cathode.

3. The solid oxide fuel cell according to Claim 1, further comprising at least one heating portion configured to heat the solid oxide electrolyte and generate a temperature gradient from the first and second regions.

4. The solid oxide fuel cell according to Claim 1, wherein the composition varies continuously from the first region to the second region.

5. The solid oxide fuel cell according to Claim 1, wherein the composition varies in a stepwise manner from the first region to the second region.

6. The solid oxide fuel cell according to Claim 1, further comprising at least one sealing portion configured to seal the second region.

7. The solid oxide fuel cell according to Claim 6, wherein the sealing portion is made from one or more materials selected from the group consisting of glass, ceramic, carbon, metal, and cermet.

8. The solid oxide fuel cell according to Claim 1, wherein the solid oxide electrolyte comprises, as a base material, at least one oxide selected from the group consisting of:

an oxide comprising lanthanum (La), strontium (Sr), gallium (Ga), magnesium (Mg), and, as A, one or both of cobalt (Co) and nickel (Ni);

ceria oxide;

zirconia oxide;

and a mixture thereof.

9. The solid oxide fuel cell according to Claim 1, wherein the solid oxide electrolyte is an oxide comprising lanthanum (La), strontium (Sr), gallium (Ga), magnesium (Mg), and, as A, one or both of cobalt (Co) and nickel (Ni).

10. The solid oxide electrolyte fuel cell according to Claim 1, wherein the solid oxide electrolyte is an oxide comprising lanthanum (La), strontium (Sr), gallium (Ga), magnesium (Mg), and, as A, one or both of cobalt (Co) and nickel (Ni),

wherein a magnesium (Mg) concentration is higher in the first region than in the second region,

and wherein an A concentration is higher in the second region than in the first region.

11. The solid oxide electrolyte fuel cell according to Claim 1, wherein the solid oxide electrolyte is an oxide comprising lanthanum (La), strontium (Sr), gallium (Ga), magnesium (Mg), and, as A, one or both of cobalt (Co) and nickel (Ni),

wherein a magnesium (Mg) concentration is higher in the first region than in the second region,

and wherein an A concentration is zero in the first region and greater than zero in the second region.

12. The solid oxide fuel cell according to Claim 1, wherein the solid oxide electrolyte further comprises at least one intermediate region between the first and second regions, said intermediate region having an intermediate operating temperature between said high and low operating temperatures.

13. The solid oxide fuel cell according to Claim 1, wherein the solid oxide electrolyte further comprises at least one intermediate region between the first and second regions, said intermediate region having an intermediate operating temperature between said high and low operating temperatures,

wherein the compositions of the second and intermediate regions comprise, as a base material, a stabilized zirconia oxide comprising yttria and scandia,

wherein the yttrium concentration is higher in the second region than in the first region,

and wherein the scandium concentration is higher in the first region than in the second region.

14. The solid oxide fuel cell according to Claim 1, wherein the solid oxide electrolyte comprises:

as a base material of the second region, an oxide comprising cerium (Ce) and, as B, one or both of samarium (Sm) and gadolinium (Gd);

and, as a base material of the first region, a stabilized zirconia oxide comprising yttria and Scandia.

15. The solid oxide fuel cell according to Claim 1, wherein the solid oxide electrolyte has the composition $La_{0.8}Sr_{0.2}Ga_{0.8}Mg_{0.2-X}A_XO_{3-Z}$ or $La_{0.9}Sr_{0.1}Ga_{0.8}Mg_{0.2-X}A_XO_{3-Z}$

wherein A is one or both of cobalt (Co) and nickel (Ni),

wherein Z is 0-0.2,

and wherein X is 0.08-0.

16. The solid oxide fuel cell according to Claim 1, wherein the solid oxide electrolyte has the composition $La_{0.8}Sr_{0.2}Ga_{0.8}Mg_{0.2-X}A_XO_{3-Z}$ or $La_{0.9}Sr_{0.1}Ga_{0.8}Mg_{0.2-X}A_XO_{3-Z}$

wherein A is one or both of cobalt (Co) and nickel (Ni),

wherein Z varies from zero to 0.2 moving from the second region to the first region,

and wherein X varies from 0.08 to zero moving from the second region to the first region.

17. The solid oxide fuel cell according to Claim 1, wherein the solid oxide electrolyte has the composition of $Ce_{0.8}B_{0.2}O_{1.9-\delta}$

wherein B is one or both of samarium (Sm) and gadolinium (Gd);

and wherein δ is 0-0.4.

18. The solid oxide fuel cell according to Claim 1, wherein the solid oxide electrolyte has the composition $Ce_{0.8}B_{0.2}O_{1.9-\delta}$

wherein B is one or both of samarium (Sm) and gadolinium (Gd);

and wherein δ varies from zero to 0.4 moving from the second region to the first region.

19. The solid oxide fuel cell according to Claim 1, wherein the solid oxide electrolyte has the composition $Zr_{0.8}Sc_{0.2-X}Y_XO_{1.9-Z}$

where Z is 0-0.4,

and wherein X is 0-0.2.

20. A method for making the solid oxide fuel cell according to Claim 1, comprising disposing the solid oxide electrolyte between the anode and the cathode.

21. A fuel cell module, comprising one or more of the solid oxide fuel cells according to claim 1, at least one fuel supply passage configured to supply at least one fuel to the anode;

at least one oxidant supply passage configured to supply at least one oxidant to the cathode; and

at least one heating portion configured to heat the solid oxide electrolyte and generate a temperature gradient from the first and second regions.

22. A method for producing electricity with the solid oxide fuel cell of Claim 1, comprising, contacting the anode with a fuel and contacting the cathode with an oxidant.

23. An ionically conducting solid oxide electrolyte, comprising:

at least one first region having a relatively high operation temperature and at least one second region having a relatively low operation temperature;

and wherein the composition of the solid oxide electrolyte is different in the first and second regions.

24. A method for making the solid oxide electrolyte according to Claim 23, comprising, varying the composition of of the solid oxide electrolyte between said first and second regions, to form the ionically conducting solid oxide electrolyte.